Technology developments to address ESA's challenges for new times
Opportunities for Poland

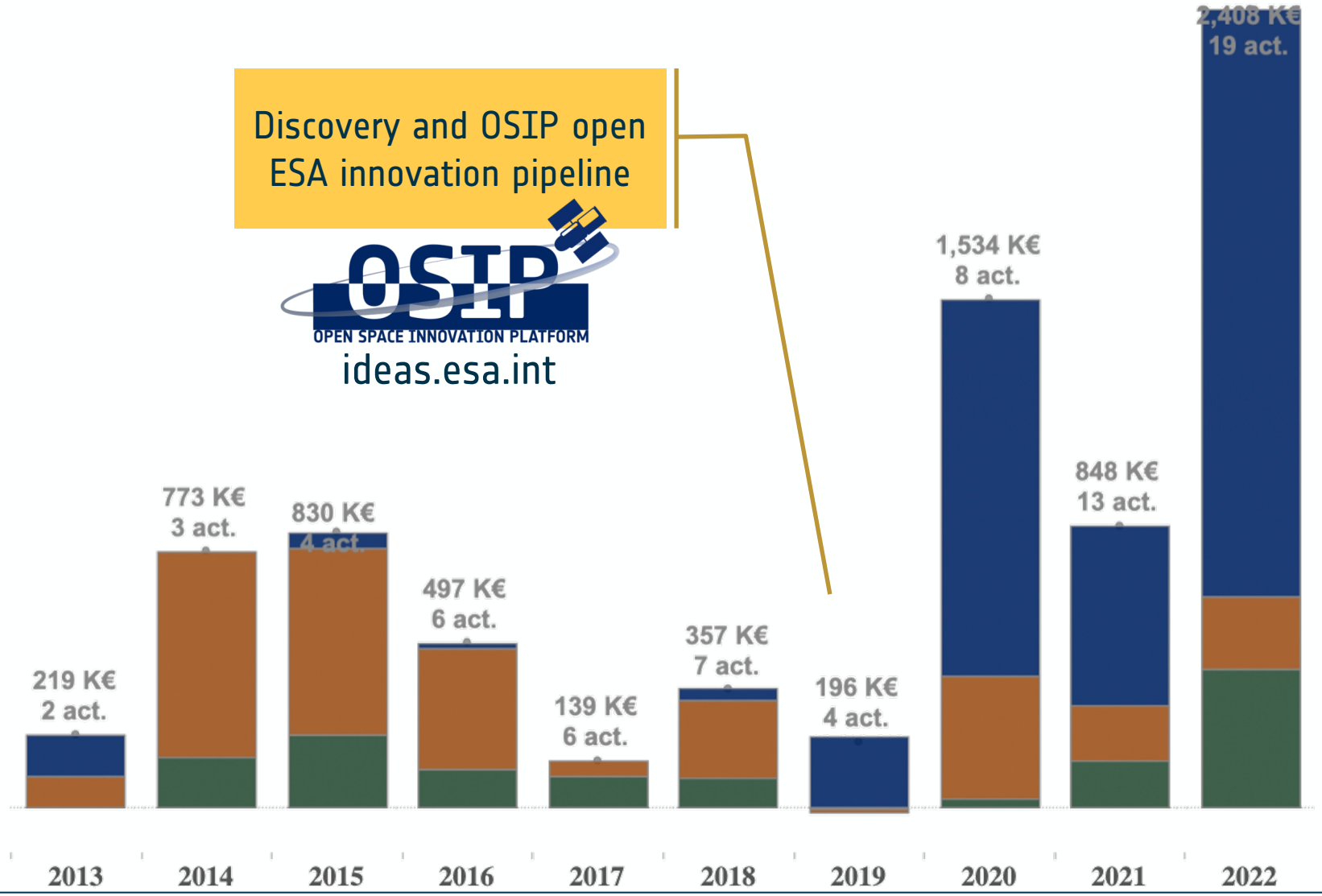
L. Summerer, 27 October 2022

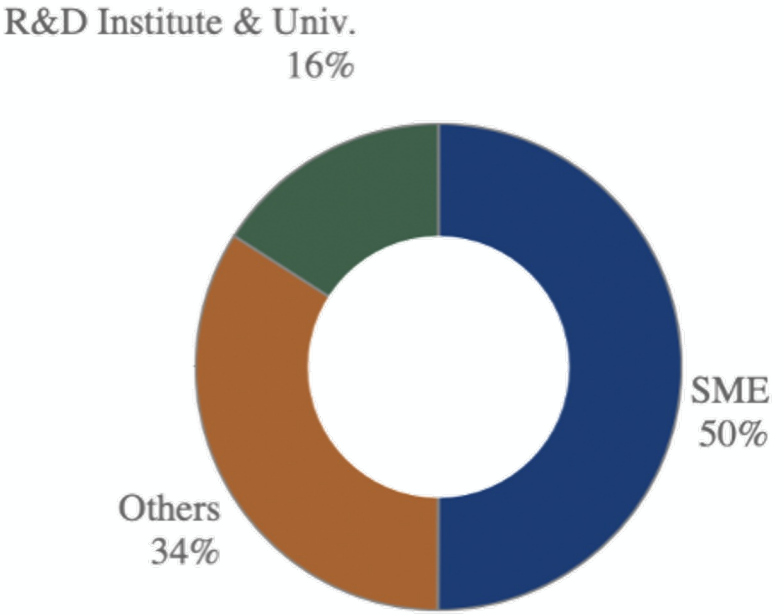
DISCOVERY, PREPARATION AND TECHNOLOGY DEVELOPMENT

Discovery and OSIP open ESA innovation pipeline

OSIP OPEN SPACE INNOVATION PLATFORM

ideas.esa.int





DISCOVERY, PREPARATION AND TECHNOLOGY DEVELOPMENT

Disruptive Ideas

- Fast and Open
- Interactive
- Novelty driven
- Outside driven
- Open competitive
- Low budget
- Commercialisation
- Research projects & early techn. dev.

Discovery

Future Missions

- First mission baseline
- Pre-phase A/Phase A
- ESA driven
- MBSE baseline
- Mission enabling
- Across all domains
- Open competitive
- LSI consortia
- CDF Studies

Preparation

Technology

- low TRL
- Generic
- Enabling missions
- 2yr Work plans
- SME focus
- ESA driven
- Across all domains
- Open competitive

➢ **WP 23/24 is being released**

TDE

- higher TRL
- Enabling missions
- Supporting Competitiveness
- Work plans & industry-proposals
- SME focus
- Delegation support
- 3 Elements + components

➢ **2 new compendia**

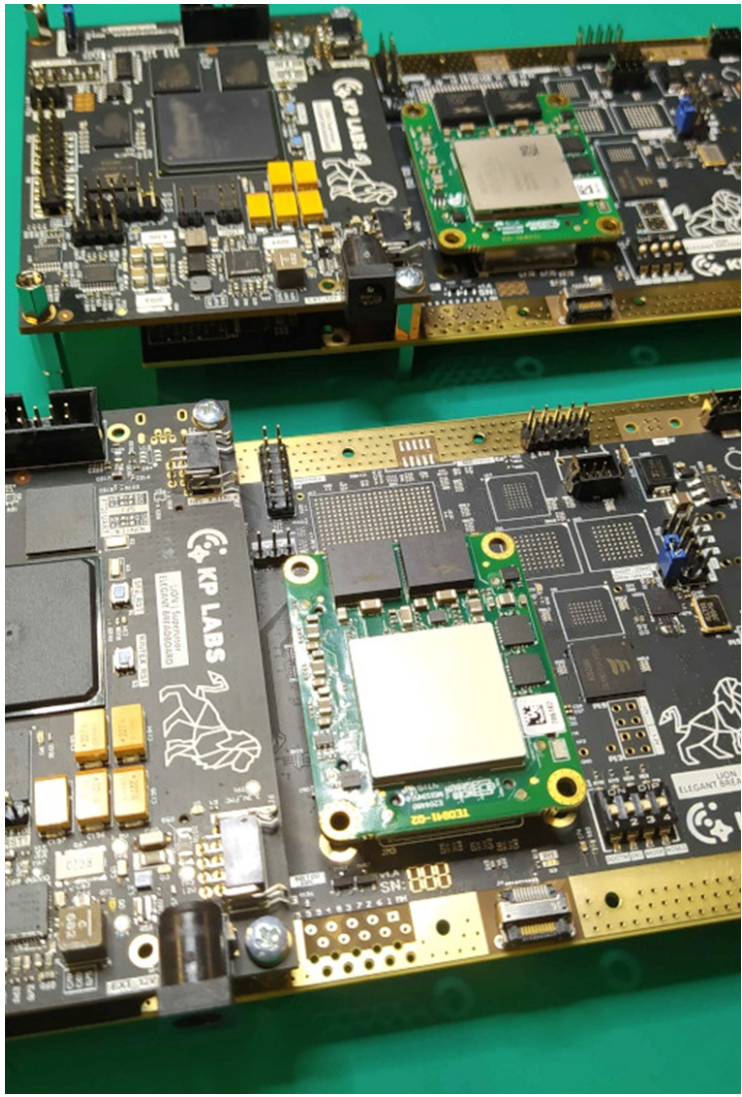
GSTP

DISCOVERY
QUANTUM RECEIVERS DEEP-SPACE OPTICAL COMMUNICATIONS

TDE- SECURE REPROGRAMMABILITY FOR CRITICAL AVIONICS FUNCTIONS QUANTUM-SAFE REPROGRAMMABILITY

QUASAR = QUAntum-SAfe Reprogrammability of critical avionics functions

- KP Labs prototypes a secure reprogramming function of on-board critical avionics functions based on FPGA
- Relying on XMSS, a long-term secure digital signature algorithm considered Quantum-resistant by cryptography experts
- Prototype will demonstrate such capability by updating cryptographic algorithms used for the protection of spacecraft telecommand and telemetry data
- Crypto-agility, ability to reprogram secure communications cryptography in-flight, considered very valuable

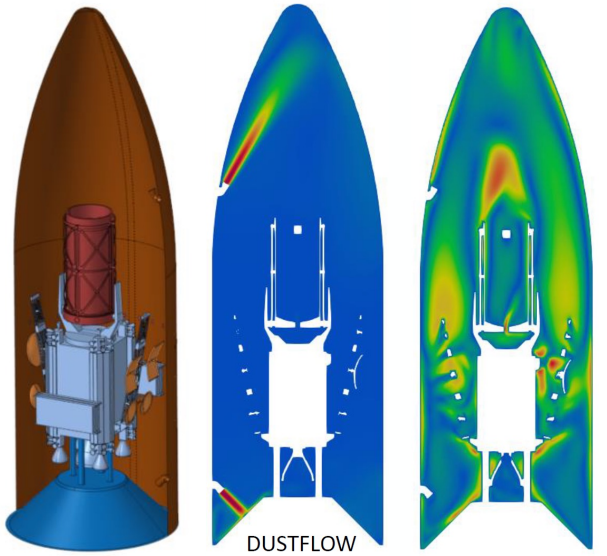


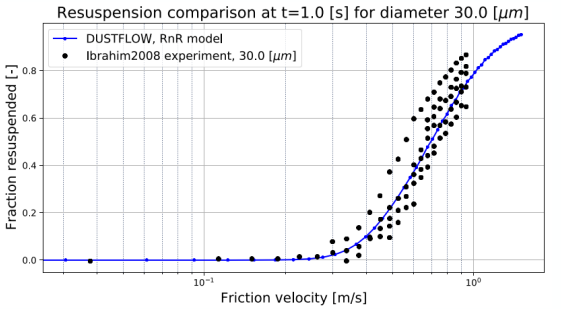
TDE- PARTICLE MODELLING INSIDE FAIRINGS

- Advanced simulation tool to compute particulate transport and deposition during pre-launch and launch phases
- Supports verification of particulate contamination requirements for s/c and instruments
- Challenging complexity of dealing with different flow regimes, adhesion forces, multiphysics - interfaces between spacecraft and launchers
- First part successfully concluded in 2022
- Second part to address venting, and lunar dust

DUSTFLOW

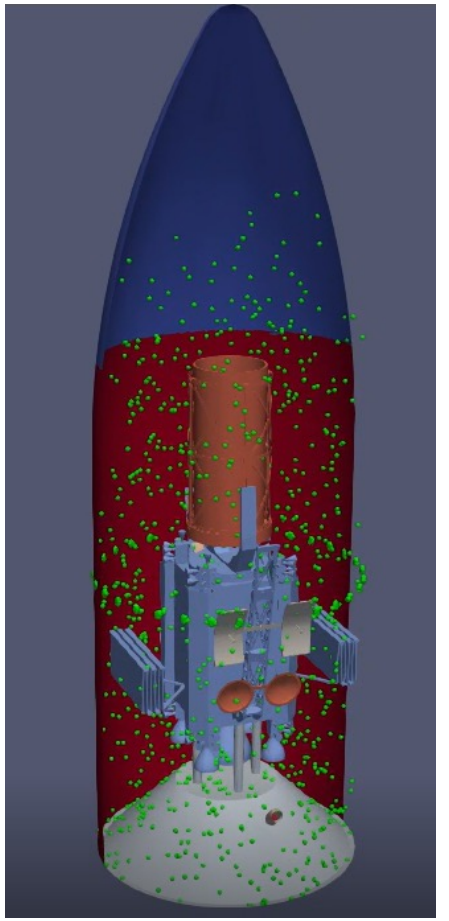
Geometry Pre-launch Launch



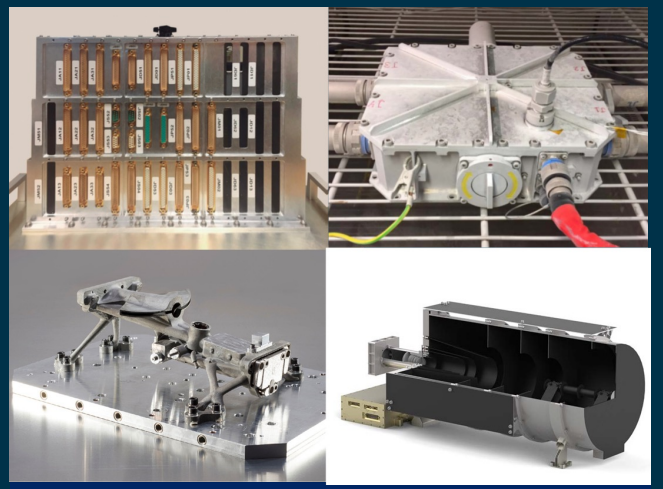


SKA Polska CIM-mes Projekt

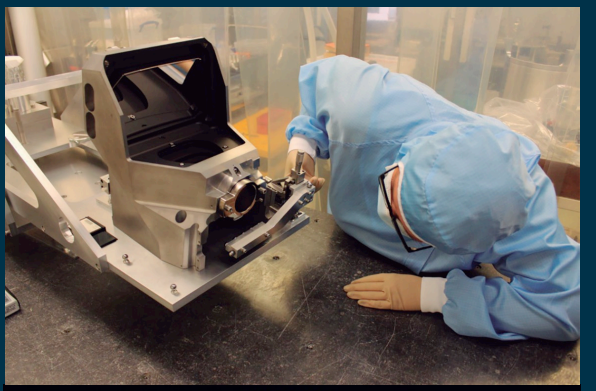
Particle redistribution



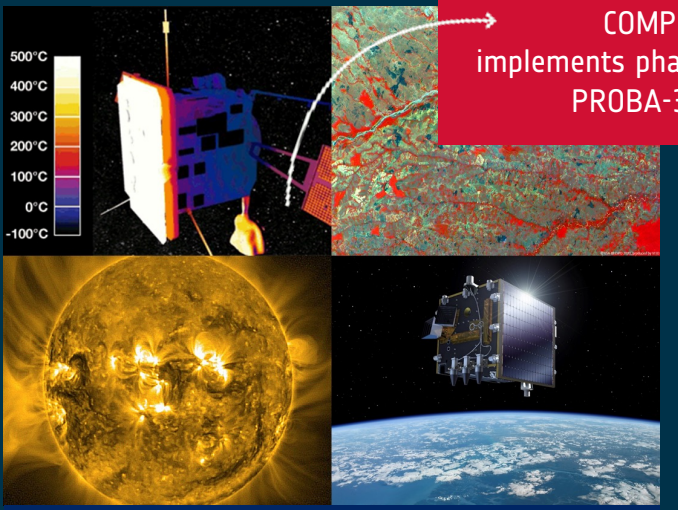
GSTP STRUCTURE



ELEMENT 1: DEVELOP



ELEMENT 2: MAKE



ELEMENT 3: FLY

COMPONENTS

PRECISE FORMATION FLYING COMPONENT
implements phases C/D/E of the PROBA-3 mission

Supports technology developments up to qualification, capacity building & ESA technology aims.

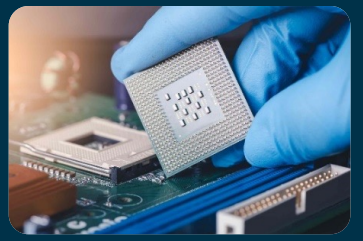
→ Compendia, Work Plan, Frameworks

→ Industry initiated and driven, co-funded activities to strengthen competitiveness

On-ground and in-orbit demonstrations of technologies in need of acquiring in-orbit validation.

Specific Areas in Element 1: Cyber Security and Space-Based Solar Power
Two additional Components are proposed in the context of CM-22:
EEE Space Component Sovereignty for Europe and EuropeaN Devices Using Radioisotope Energy (ENDURE)

EEE Sovereignty + ENDURE Radioisotope Energy + SOLARIS



EEE

Space Component Sovereignty for Europe

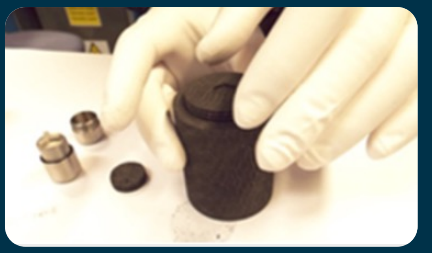
Establishing long-term sustainable access to state-of-the-art EEE component technologies;
Addressing critical dependency: >50% procured outside Europe, e.g. >95% US FPGAs on ESA s/c

- Enabling European competitiveness
- long-term industrial value chain partnerships
- Agile development and procurement approach

Initial focus on strategic technologies:

- Ultra Deep Sub-micron, FPGAs, RF GaN, power components (GaN & SiC), Solar Cells, Packaging/Printed Circuit Boards, photonics components, EEE-component test facilities

⇒ Target: 150M€ 2023+ (5 year outlook)



ENDURE

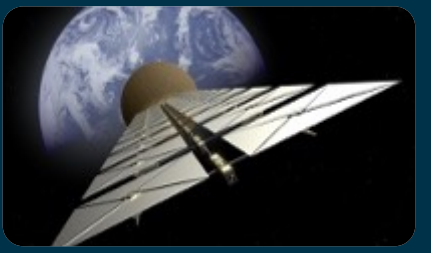
EuropeaN Devices Using Radioisotopes

Establishing capacity to develop & use radio-isotope power sources for exploration & science

- Outer solar system, long-term Moon & Mars
- Full dependence on US and Russian RPS
- Precursor technology dev. demonstrated viable path for European RPS before end of decade:
  - TRL 4 for RHUs & RTGs based on Am-241 from re-processing of nuclear waste
  - Fuel production & encapsulation demonstrated, incl. production of sub-scale Am-241 oxide pellets

Technology lines: Fuel Production, Pelleting, Encapsulation, Power Systems Development

⇒Target: 40M€ (2023-25)



SOLARIS

Space based solar power technology

Preparing technological basis for space based solar power plants
Potential direct space contribution to Energy sector target of NetZero 2050

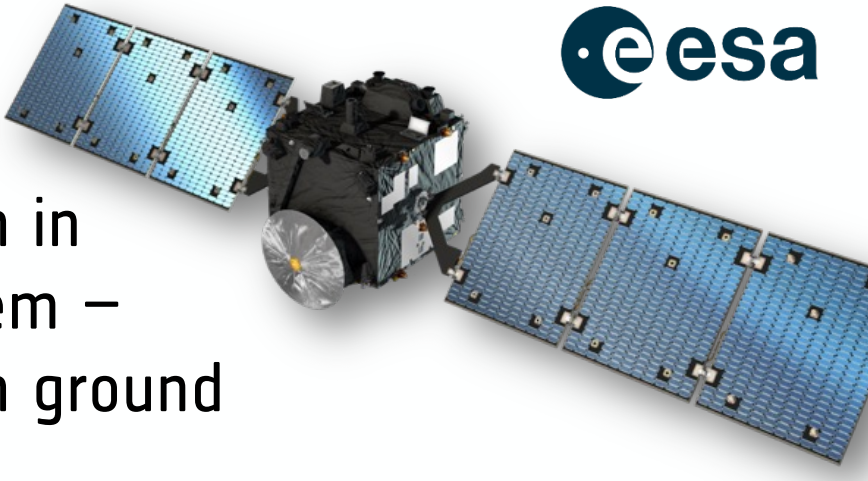
- Preparatory programme

Initial focus on system critical technologies:

- High mass-efficiency solar PV conversion
- High-efficiency RF generation and accurate beam forming
- High power management and distribution
- Large scale structures deployment, in-space manufacturing, robotic assembly and maintenance

⇒ Target: 60M€ (2023-25)
Special area in GSTP Element 1

GSTP POLISH PARTICIPATION



Participation in GSTP since 2012, ~2% of overall envelope, total subscription: 32M€

Main areas of interest:

- Guidance Navigation and Control
- Active debris removal
- Power amplifiers
- Ground system software
- Multiprotocol on board communication
- Artificial intelligence applications in image processing
- Advanced manufacturing and additive manufacturing
- Green propulsion and propellants

Important participation in European Ground System – Common Core (common ground infrastructures)

Important participation in HERA

- started in GSTP now in S2P
- important role in visual navigation and GNC development

GSTP TECHNOLOGY MATURATION

Technology maturation

- Following completion of de-risk phase of LION DPU: possibility to implement a first product portfolio framework for this development
- Use of product portfolio framework, e.g. for microsatellite platform development

Future areas of engagement

Aluminium coatings

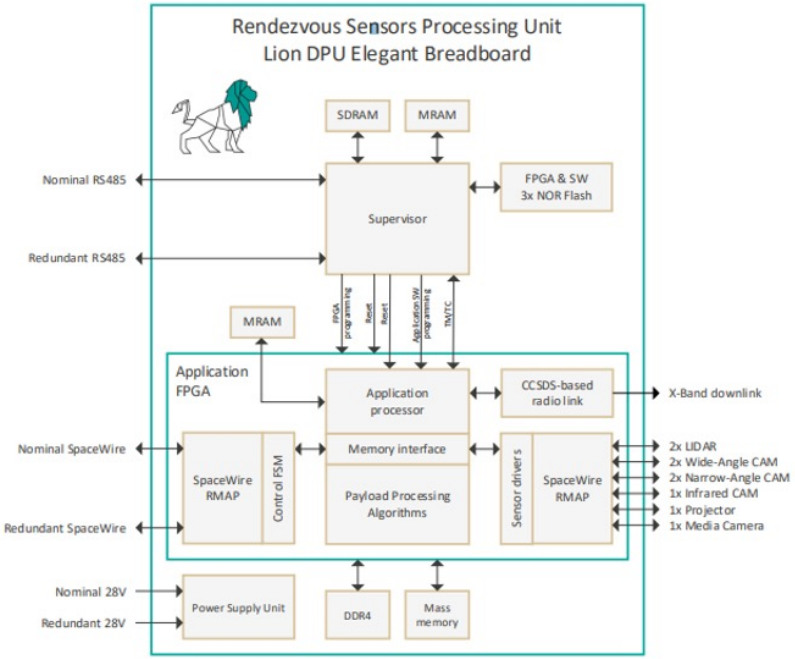
Vibration control

Oscillator dampers

Control electronics for pointing mechanisms

L-Band antennas for GNSS and ground applications on S-Band and L-Band

Energy systems

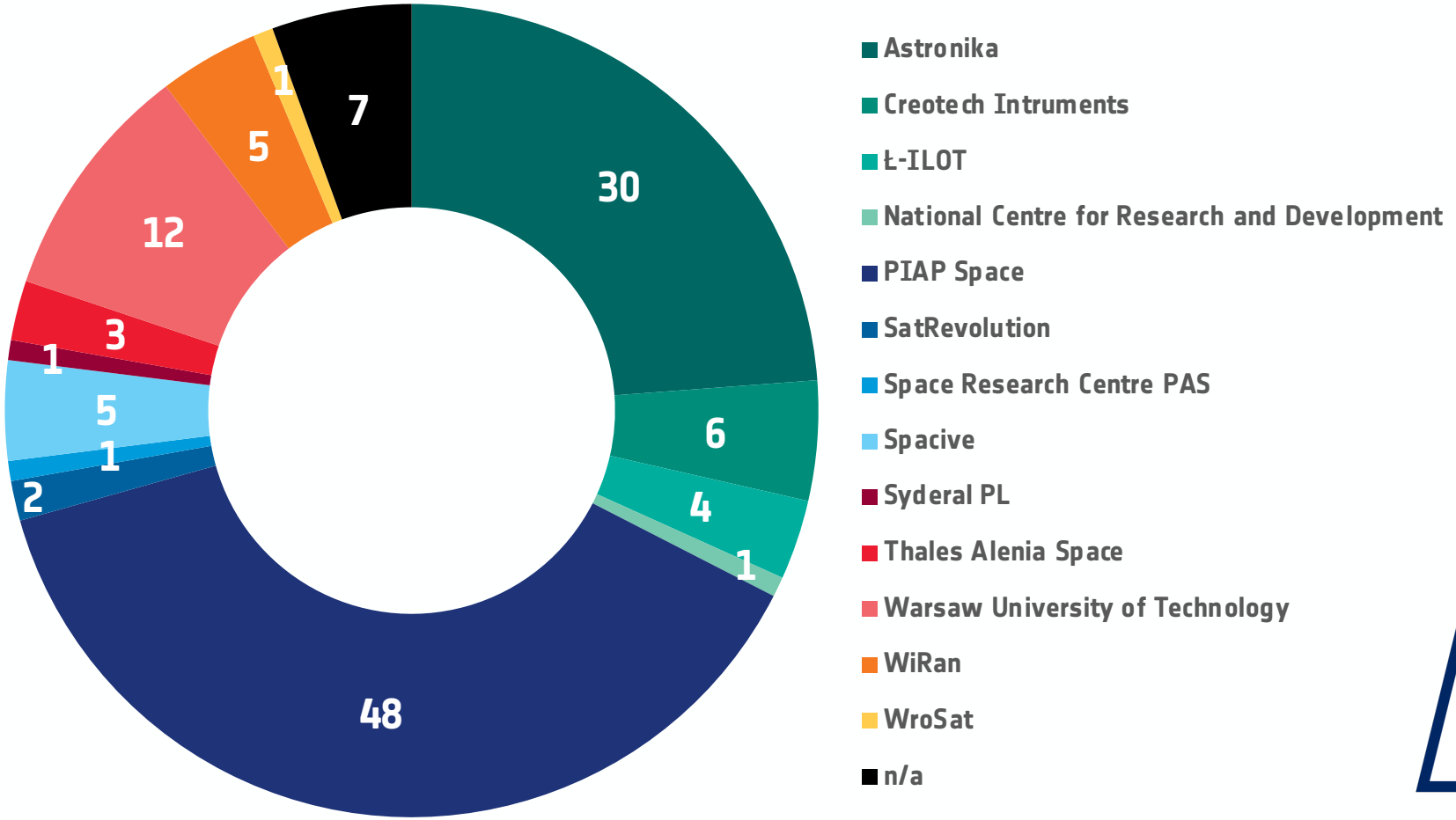


2021/2022 ECSS TRAINING COURSE ATTENDANCE – POLAND

13 Polish organisations

11.2% attendees (Polish organisations)

126 total attendance (Polish organisations)



- Astronika
- Creotech Intruments
- Ł-ILOT
- National Centre for Research and Development
- PIAP Space
- SatRevolution
- Space Research Centre PAS
- Spacive
- Syderal PL
- Thales Alenia Space
- Warsaw University of Technology
- WiRan
- WroSat
- n/a

52 individual attendees (Polish organisations)

2.42 average number of courses attended

ESA TECHNOLOGY STRATEGY – IMPLEMENTING AGENDA 2025

TECHNOLOGY AND ENGINEERING TARGETS

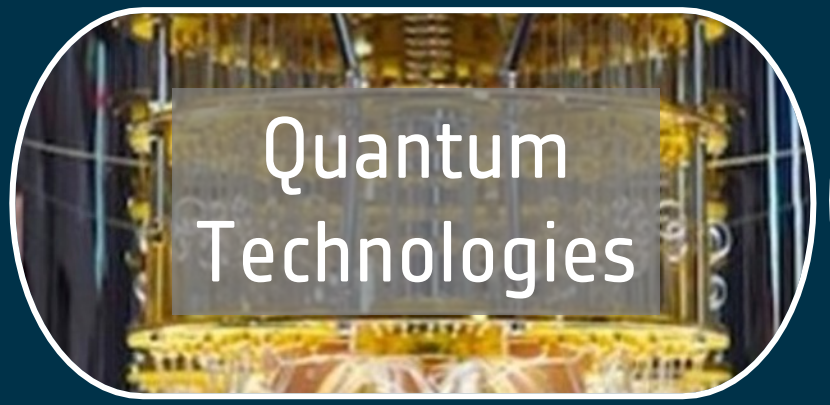
30% IMPROVEMENT OF S/C DEVELOPMENT **TIME**

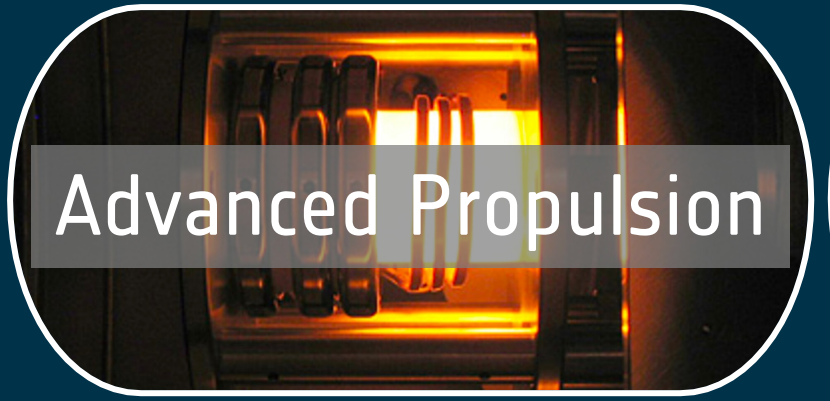
ORDER OF MAGNITUDE BETTER **COST EFFICIENCY** WITH EVERY GENERATION

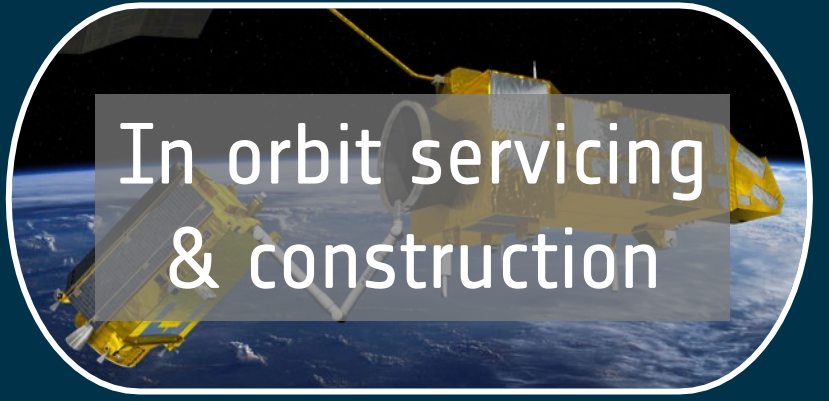
30% **FASTER** DEVELOPMENT & ADOPTION OF **INNOVATIVE** TECHNOLOGY

INVERTING EUROP. CONTRIBUTIONS TO SPACE **DEBRIS** BY 2030

3 NEW TECHNOLOGY INITIATIVES



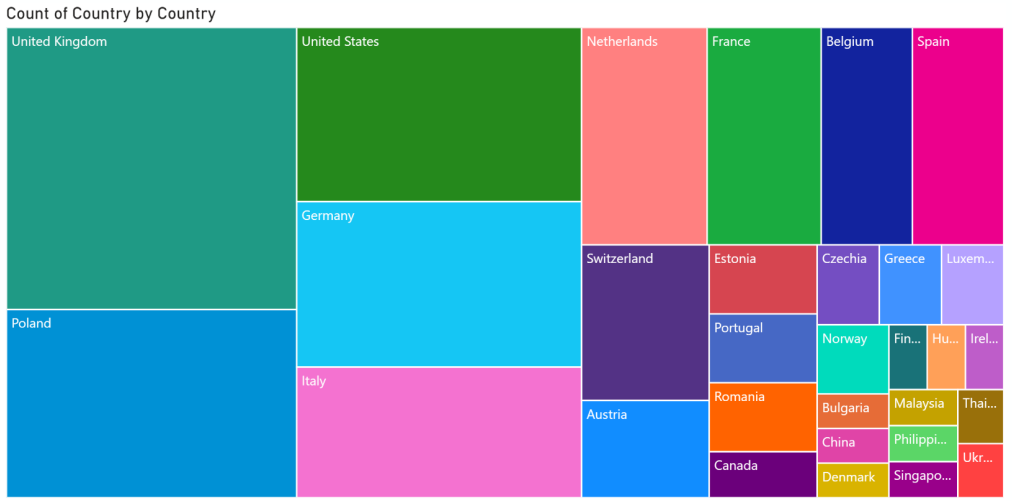




Backup Slides

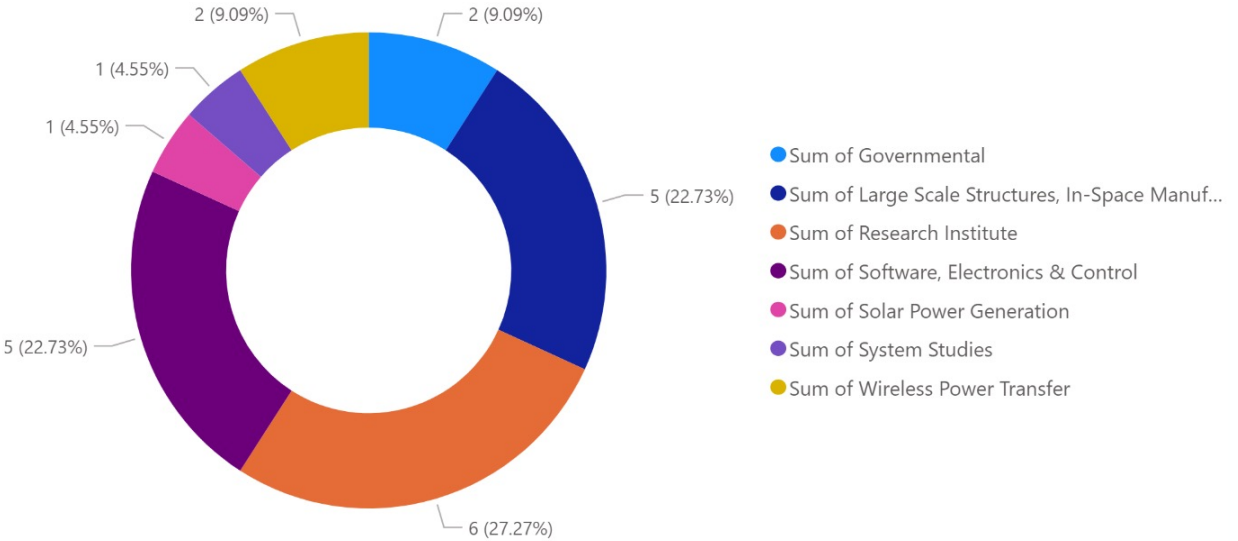
SOLARIS INDUSTRY DAY (18.10.22)

Distribution by country of companies that registered for SOLARIS Industry day



22 companies and institutes from Poland participated - **2nd most represented country**

Distribution of field for Polish companies registered for SOLARIS Industry day



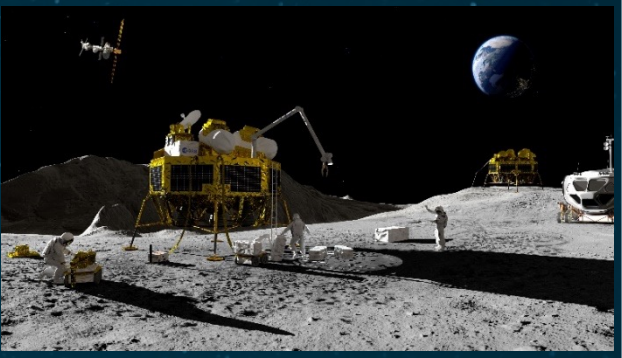
Multidisciplinary interest from companies and research institutes

Greatest interest in the fields of Large Scale manufacturing, in-space manufacturing, robotic assembly and maintenance, and also in Software, Electronics and Control

RATIONALE FOR A EUROPEAN RADIOISOTOPIC POWER SOURCES CAPABILITY

Exploration of the outer solar system and nighttime survival on Moon / Mars requires solar independent power

- RadioIsotope Power provides an efficient, reliable and in many cases the only solution

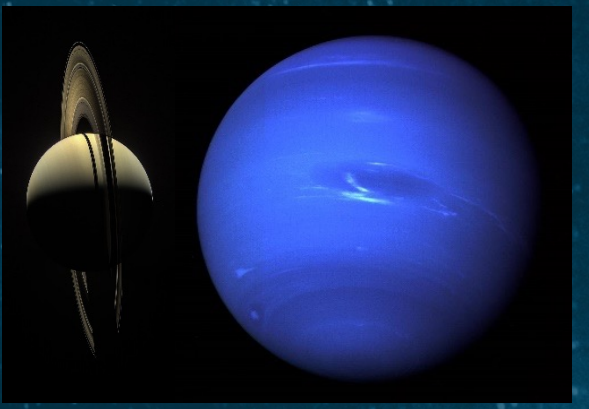


Europe does not have an independent RPS capability.

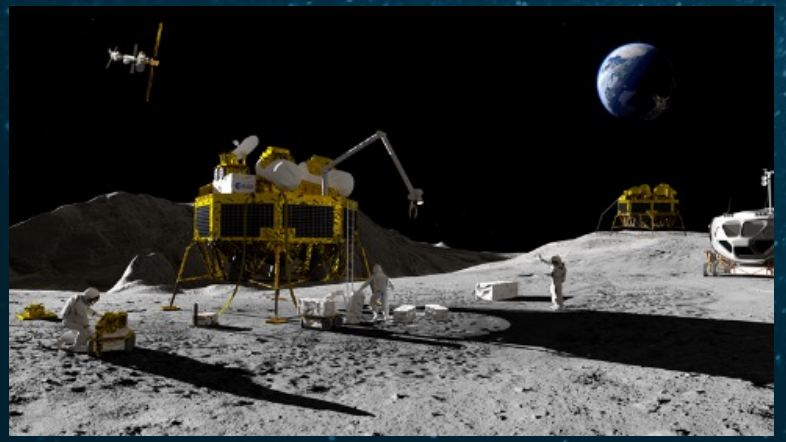
➢ **Any European mission requiring RPS is contingent on International partners to provide fuel, systems and launch**

ESA Exploration Missions (HRE and SCI) in the 2030's onwards require RPS

- **Moon:** HRE *Terra Novae 2030+* Robotic landers, payloads, surface infrastructure
- **Mars:** HRE *Terra Novae 2030+* Robotic surface missions, support to human missions
- **Outer Solar System:** the SCI Voyage 2050 - missions to Outer planets, contributions to international outer solar system missions, Icy moons sample return Inspirator



EuropeaN Devices Using Radioisotope Energy (ENDURE)



The aim is to deliver an end-to-end European operational capability for RPS heat and power systems by the end of this decade

Phase 1 (GSTP Component) Objectives

- **Establish an operational Am-241 fuel production capability** capitalising on previous developments and European / National partner capabilities

- **Mature radioisotope power system technologies**
  - Radioisotope Heating Unit (RHU and ELHS) (up 200 ThW TBC)
  - Radioisotope Thermal Generator (RTG) (about 10eW TBC)
  - Radioisotope Stirling Generator (RSG) (about 100eW)

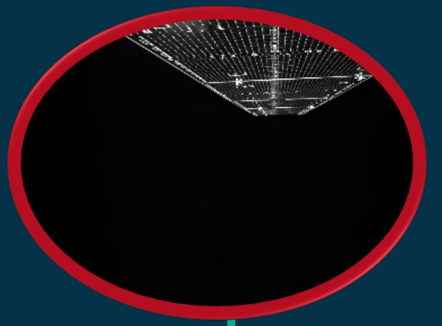
Implementation principles based on the GSTP Element 1 Develop approach
Work plans shall be structured according to technology lines

EEE SPACE COMPONENT SOVEREIGNTY FOR EUROPE

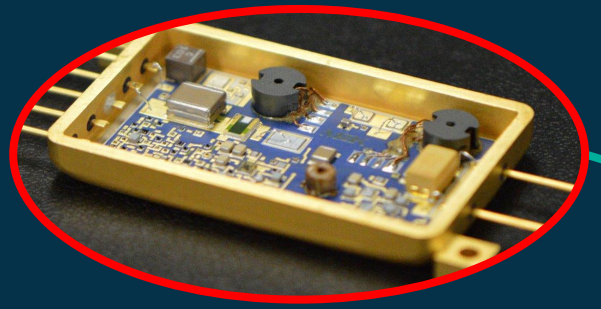
- Establishing a long-term sustainable and uninterrupted access of state-of-the-art technologies to ESA programmes through long term partnership with European Supply-Chains.
- Enabling European competitiveness, by ensuring that the right technology, at the right maturity level is available at the right time unhindered by (export) restrictions.
- Fostering long-term industrial partnerships with strategic EEE-manufacturers allowing continuous access of relevant EEE Components.
- Pursuing a tight-knit collaborative framework mechanism with supply-chain, end users and ESA programme directorates with flexible development up to qualification, adopting E2E secured funding to achieve time-to-market.
- Smart verification and qualification approach including flight on IOD/IOV as part of process acceleration (time-to-market)
- Optional Activity as a GSTP Component

EEE KEY TECHNOLOGY LINES

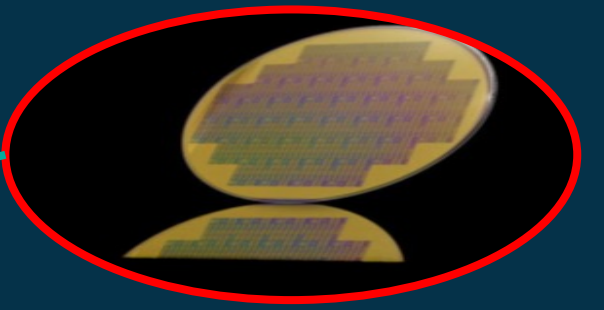
Solar Cells

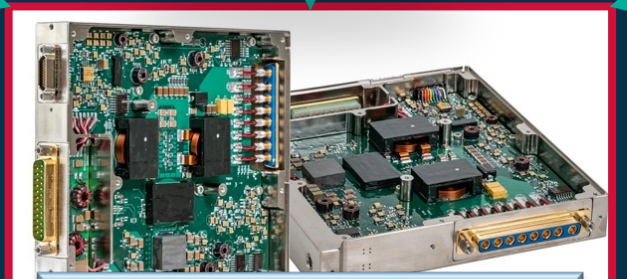


Packaging and Hybrids, PCB, Electronic assembly

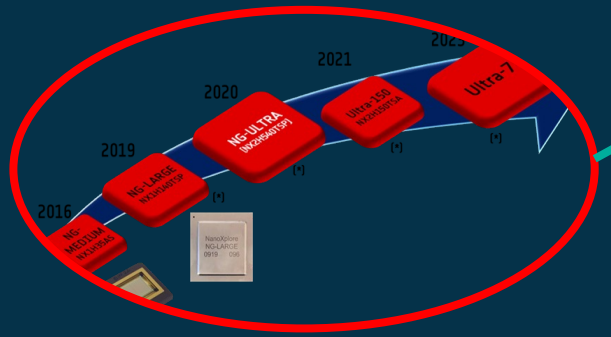


Wide Band Gap: GaN/SiC Microwave/Power





Test Facilities



(Ultra)Deep Sub Micron

Photonics

FIRST STEPS FOR NOVEL IDEAS – DISCOVERY ELEMENT PROCESS STEPS

Your Novel Idea

Your action

- You focus on describing your idea in form of an abstract
- No need for formalities
- Submit any time to Open Discovery Channel on OSIP
- Ideas for future commercially viable activities welcome

OSIP Channel

- Permanently open
- All novel space ideas welcome

OSIP Campaigns

- Time limited
- ESA defined challenges / topics

OSIP (ideas.esa.int)

- ESA gives you feedback
- ESA channels ideas to best implementation path
- Monthly evaluation for Discovery channel ideas
- Best ideas invited to be matured into proposals

Discovery Contracts

- Following competitive evaluation
- Co-sponsored research (<90k)
- Study (<100k)
- Early Technology Development (<175k)

GSTP, InCubed, ARTES, NAVISP …

- Programme specific

PREPARING NEW MISSIONS – PREPARATION ELEMENT PROCESS STEPS

ESA Mission Definitions

- New mission concepts from ESA directorates
- CDF Studies preparing solid baselines

Industry proposed systems

- Temporary open idea campaigns on OSIP on new space systems and concepts
- Organised ESA-wide (e.g. what's next campaign) or by directorates

Your action

esastar

esa-star Publication

- Preparation Element Work plan (IPC)
- Look for ITT on esastar
- Submit proposal answering Statement of Work (SoW)

Your action

Preparation Contract

- Open competitively awarded across all ESA MS
- Parallel contracts to identify and develop best baseline
- 0.5-2M€ per study

RAISING LOW TECHNOLOGY MATURITY - TECHNOLOGY DEVELOPMENT ELEMENT

ESA identified technology needs

- ESA published 2yr TDE work plans based on future mission needs (TECNET) and ESA Technology Strategy
- Across all domains

esastar

Your action

- Look for ITT on esastar
- Form partnerships
- Submit your proposal answering ESA SoW

TDE Contract

- Following competitive evaluation
- TRL 1-4 raising technical activity
- ~500k€ per activity
- Parallel contract

RAISING TECHNOLOGY MATURITY AND PREPARING FOR FLIGHT - GSTP

ESA identified technology

- GSTP Elements 1 & 3: ESA initiated Work Plan activities from GSTP Compendia (published in esastar news)
- GSTP Elements 1 & 3: *ad-hoc* activities (e.g. TDE follow-on)

Industry proposed technology

- Outline proposals submitted to open **GSTP channels on OSIP**:
  - GSTP Element 1: De-risk channel (OSIP)
  - GSTP Element 2: Industry initiated (market-oriented) proposals (OSIP)

Your action

esastar

esa-star Publication

- Look for ITT on esastar
- Support letter from delegation
- Submit proposal answering Statement of Work (SoW)

Your action

esastar

- Submit full proposal without SoW
- Support letter from delegation
- ESA evaluation

Your action

GSTP Contract

- Higher TRL technical activity up to in-orbit demonstration (IOD)
- 0.5-5M€ per activity

Element 1 DEVELOP	Building capabilities
Element 2 MAKE	Co-funded, competitiveness
Element 3 FLY	IODs